

# Xin Wang

*Postdoctoral Researcher*

Industrialized Construction Innovation

National Renewable Energy Laboratory (NREL)

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## EDUCATION

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- 01/2020 – 06/2024 Ph.D. in Civil Engineering, *University of Wisconsin-Madison*  
GPA: 4.0 / 4.0  
Advisor: Zhenhua Zhu  
Dissertation Title: “Context-Aware Worker Intent Interpretation for Human-Robot Collaboration in Construction”
- 01/2020 – 05/2021 M.S. in Computer Science, *University of Wisconsin-Madison*  
GPA: 4.0 / 4.0
- 09/2016 – 06/2019 M.S. in Civil Engineering, *Tongji University*  
GPA: 91.5 / 100  
Advisor: Hehua Zhu  
Dissertation Title: “Study on Serviceability Degradation Model of Shield Tunnel Through Data Mining Methods”
- 02/2016 – 05/2016 Exchange Student in Civil Engineering, *Korea Advanced Institute of Science and Technology*
- 09/2012 – 06/2016 B.S. in Civil Engineering, *Tongji University*  
GPA: 4.74 / 5.0

## PROFESSIONAL POSITIONS

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- 09/2024 – present Postdoctoral Researcher, *National Renewable Energy Laboratory*
- 07/2024 – 09/2024 Postdoctoral Researcher, *University of Wisconsin-Madison*

## ACHIEVEMENTS AND AWARDS

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- 2024 Best Paper Award Across All Tracks (~ 400 Papers)  
CI & CRC Joint Conference, Des Moines, Iowa  
*American Society of Civil Engineers*
- 2023, 2021 Scholarship for Student Research Grants Competition - Conference Presentation  
*University of Wisconsin-Madison*
- 2022 Best Academic Paper Award  
Transforming Construction with Reality Capture Technologies Conference, Canada  
*Canadian Society for Civil Engineering*
- 2022 First Place in Five-Minute Student Research Competition  
Transforming Construction with Reality Capture Technologies Conference, Canada  
*Canadian Society for Civil Engineering*
- 2022 First Place in VIMS-IAARC Joint Datathon 2022 Competition  
*American Society of Civil Engineers*
- 2017 Residential Construction Scholarship  
*Tongji University*

2016	Awards of Outstanding Undergraduate Graduates <i>Tongji University</i>
2016	International Exchange Scholarship for Undergraduate Students <i>China Scholarship Council</i>
2015	National Scholarship for Undergraduate Students <i>Chinese Ministry of Education</i>
2015	Awards of Outstanding Undergraduate Students <i>Tongji University</i>
2015, 2013	First-Class Academic Scholarship <i>Tongji University</i>
2015	Awards of Outstanding Undergraduate Students <i>Tongji University</i>
2015	Honorable Mention in American Mathematical Contest in Modeling <i>Consortium for Mathematics and its Applications</i>
2014	Second-Class Academic Scholarship <i>Tongji University</i>
2014	Second Prize in China Undergraduate Mathematical Contest in Modeling <i>Chinese Ministry of Education</i>

## RESEARCH INTERESTS

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- Human-Robot Interaction
- Construction Automation and Robotics
- Artificial Intelligence in Construction
- Building Decarbonization and Resilience

## RESEARCH EXPERIENCES

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09/2024 – present    Industrializing Construction to Decarbonize Buildings, *U.S. Department of Energy*

*Advised by Naveen Kumar Muthumanickam and Shanti Pless, NREL*

- Investigated the effects of different HVAC systems and their installation methods on the building energy performance.
- Integrated different data types (e.g., cameras, sensors) into one high-fidelity simulation model of the entire construction process.
- Utilized robotics technologies to reach out to hot and uncomfortable cavities for performing a variety of retrofit tasks in distinct building types.

01/2020 – 08/2024    Hand Gesture Recognition for Human-Robot Collaboration in Construction, *Wisconsin Alumni Research Foundation*

*Advised by Prof. Dharmaraj Veeramani and Prof. Zhenhua Zhu, UW-Madison*

- Proposed a vision-based framework including worker detection and tracking, frame cropping, and

hierarchical recognition architecture, to capture and interpret the hand gestures of workers.

- Developed a wearable sensor-based system including data preprocessing, window sliding and modified FCN gesture classifier, to facilitate the accurate classification of hand gestures.
- Integrated the collaborative context information, such as which machine the worker intends to interact with, the contextual object information, to enhance the functionality and efficiency of the gesture interface.

06/2022 – 07/2022 Transformer-based Segmentation for Recycling Materials in Construction, *VIMS-IAARC Joint Datathon 2022 Competition*

*Advised by Prof. Yin Li and Prof. Zhenhua Zhu, UW-Madison*

- Evaluated three state-of-the-art transformer-based architectures on construction image segmentation tasks.
- Established an ensemble model utilizing the techniques of model soup and probability weighting for performance improvement.

09/2017 – 12/2019 Application of Information Technologies in Efficient Tunneling Boring Machine (TBM) Construction and Maintenance, *National Basic Research Program of China*

*Advised by Prof. Hehua Zhu, Tongji University*

- Utilized data mining methods including Long Short-Term Memory (LSTM) and clustering analysis to identify the different degradation patterns and predict the future performance of shield tunnels.
- Proposed an integrated data mining approach including data cleaning, partition of full tunneling cycles, feature extracting, and machine learning models, to perform real-time prediction of critical TBM operational parameters.

## PUBLICATIONS

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### Refereed Journal Articles

- J11. **Wang, X.**, Veeramani, D., Dai, F., Zhu, Z., 2024. Context-Aware Hand Gesture Interaction for Human-Robot Collaboration in Construction. *Computer-Aided Civil and Infrastructure Engineering*. DOI: 10.1111/mice.13202.
- J10. **Wang, X.**, Han, W., Mo, S., Cai, T., Gong, Y., Li, Y., Zhu, Z., 2023. Transformer-Based Automated Segmentation of Recycling Materials for Semantic Understanding in Construction. *Automation in Construction*, DOI: 10.1016/j.autcon.2023.104983.
- J09. **Wang, X.**, Han, W., Du, E., Dai, F., Zhu, Z., 2023. An Eye Gaze-Aided Virtual Tape Measure for Smart Construction. *Canadian Journal of Civil Engineering*, DOI: 10.1139/cjce-2023-0056.
- J08. **Wang, X.**, Veeramani, D., Zhu, Z., 2023. Gaze-Aware Hand Gesture Recognition for Intelligent Construction. *Engineering Applications of Artificial Intelligence*, DOI: 10.1016/j.engappai.2023.106179.
- J07. **Wang, X.**, Veeramani, D., Zhu, Z., 2022. Wearable Sensors-Based Hand Gesture Recognition for Human-Robot Collaboration in Construction. *IEEE Sensors Journal*, DOI: 10.1109/JSEN.2022.3222801.
- J06. **Wang, X.**, Zhu, Z., 2021. Vision-Based Framework for Automatic Interpretation of Construction

- Workers' Hand Gestures. *Automation in Construction*, DOI: 10.1016/j.autcon.2021.103872.
- J05. **Wang, X.**, Zhu, Z., 2021. Vision-based hand signal recognition in construction: A feasibility study. *Automation in Construction*, DOI: 10.1016/j.autcon.2021.103625.
- J04. **Wang, X.**, Zhu, H., Zhu, M., Zhang, L., Ju, J.W., 2021. An Integrated Parameter Prediction Framework for Intelligent TBM Excavation in Hard Rock. *Tunneling and Underground Space Technology*, DOI: 10.1016/j.tust.2021.104196.
- J03. Zhu, H., **Wang, X.**, Chen, X., Zhang, L., 2020. Similarity Search and Performance Prediction of Shield Tunnel in Operation Through Time Series Data Mining. *Automation in Construction*, DOI: 10.1016/j.autcon.2020.103178.
- J02. Zhu, M., Zhu, H., **Wang, X.**, Cheng, P., 2020. Study on CART-Based Ensemble Learning Algorithms for Predicting TBM Tunneling Parameters and Classing Surrounding Rock Masses. *Chinese Journal of Rock Mechanics and Engineering*, DOI: 10.13722/j.cnki.jrme.2019.0924.
- J01. Zhu, H., Ding, W., Qiao, Y., **Wang, X.**, Han, C., Zhang, D., Li, X., 2019. Issues and Challenges in Urban Underground Space Utilization in China. *Earth Science Frontiers*, DOI: 10.13745/j.esf.sf.2019.4.19.

### Articles in Refereed Conference Proceedings

- C12. **Wang, X.**, Veeramani, D., Dai, F., Zhu, Z. Eye Gaze and Hand Gesture-Driven Human-Robot Interaction in Construction. In: 2024 CI & CRC Joint Conference, Des Moines, Iowa, Mar. 20-23, 2024.
- C11. **Wang, X.**, Han, W., Mo, S., Cai, T., Gong, Y., Li, Y., Zhu, Z. Transformer-Based Semantic Segmentation for Recycling Materials in Construction. In: 2023 ASCE International Conference on Computing in Civil Engineering, Corvallis, Oregon, Jun. 25-28, 2023.
- C10. **Wang, X.**, Han, W., Du, E., Dai, F., Zhu, Z. An Eye Tracking Based Virtual Tape Measure in Construction. In: Transforming Construction with Reality Capture Technologies, Fredericton, New Brunswick, Canada, Aug. 23-25, 2022.
- C09. **Wang, X.**, Veeramani, D., Zhu, Z. Integrated Sensor-Based Interface for Human-Robot Collaboration in Construction. In: 39<sup>th</sup> International Symposium on Automation and Robotics in Construction, Bogotá, Colombia, Jul. 13-15, 2022.
- C08. **Wang, X.**, Zhu, Z. Vision-Based Recognition of Construction Worker's Hand Signals. In: 2022 CI & CRC Joint Conference, Arlington, Virginia, Mar. 9-12, 2022.
- C07. **Wang, X.**, Zhu, Z. Wearable Sensor-based Hand Gesture Recognition of Construction Workers. In: 38<sup>th</sup> International Symposium on Automation and Robotics in Construction, Dubai, UAE, Nov. 2-4, 2021.
- C06. **Wang, X.**, Zhu, Z. Hand Signal Recognition of Workers on Construction Sites using Deep Learning Networks. In: 2021 ASCE International Conference on Computing in Civil Engineering, Orlando, Florida, Sep. 12-14, 2021.
- C05. **Wang, X.**, Zhu, M., Shen Y. Prediction of TBM Operational Parameters Using an Integrated Data Mining Framework. In: Proceedings of 11<sup>th</sup> Asian Rock Mechanics Symposium, Beijing, China, Oct.

21-25, 2021.

- C04. Zhu, M., **Wang, X.**, Zhu, H., Gutierrez, M., Ju, JW. Dynamic Prediction of Penetration Rate Based on TBM Operational Data. In: Proceedings of 11<sup>th</sup> Asian Rock Mechanics Symposium, Beijing, China, Oct. 21-25, 2021.
- C03. **Wang, X.**, Zhu, H., Zhang, L. A Three-Dimensional Damage-Softening Statistical Constitutive Model for Rock Based on GZZ Criterion. In: Proceedings of 10<sup>th</sup> Asian Rock Mechanics Symposium, Singapore, Oct. 29-Nov. 3, 2018.
- C02. Zhu, M., **Wang, X.**, Zhu, H., Gutierrez, M., Ju, JW. Dynamic Prediction of Penetration Rate Based on TBM Operational Data. In: Proceedings of 11<sup>th</sup> Asian Rock Mechanics Symposium, Beijing, China, Oct. 21-25, 2021.
- C01. Zhu, H., **Wang, X.**, Jiang, Z., Chen, Q. Study on Crack Repair of Tunnel Segment by Electrochemical Deposition Method. In: Proceedings of GeoShanghai 2018 International Conference, Shanghai, China, May. 27-30, 2018.

### **Conference Presentations and Invited Talks**

- P11. “Context-Aware Worker Intent Interpretation for Human-Robot Collaboration in Construction”. National Renewable Energy Laboratory, Golden, Colorado, August 2024.
- P10. “Context-Aware Worker Intent Interpretation for Human-Robot Collaboration in Construction”. University of Texas at Arlington, Arlington, Texas, April 2024.
- P09. “Context-Aware Worker Intent Interpretation for Human-Robot Collaboration in Construction”. University of Alabama, Tuscaloosa, Alabama, March 2024.
- P08. “Eye Gaze and Hand Gesture-Driven Human-Robot Interaction in Construction”. 2024 CI & CRC Joint Conference, Des Moines, Iowa, March 2024.
- P07. “Transformer-Based Semantic Segmentation for Recycling Materials in Construction”. 2023 ASCE International Conference on Computing in Civil Engineering, Corvallis, Oregon, June 2023.
- P06. “An Eye Tracking Based Virtual Tape Measure in Construction”. Transforming Construction with Reality Capture Technologies, Fredericton, New Brunswick, Canada, August 2022.
- P05. “Integrated Sensor-Based Interface for Human-Robot Collaboration in Construction”. 39<sup>th</sup> International Symposium on Automation and Robotics in Construction, Bogotá, Colombia, July 2022.
- P04. “Wearable Sensor-based Hand Gesture Recognition of Construction Workers”. 38<sup>th</sup> International Symposium on Automation and Robotics in Construction, Dubai, UAE, November 2021.
- P03. “Hand Signal Recognition of Workers on Construction Sites using Deep Learning Networks”. 2021 ASCE International Conference on Computing in Civil Engineering, Orlando, Florida, September 2021.
- P02. “A Three-Dimensional Damage-Softening Statistical Constitutive Model for Rock Based on GZZ Criterion”. 10<sup>th</sup> Asian Rock Mechanics Symposium, Singapore, October 2018.
- P01. “Study on Crack Repair of Tunnel Segment by Electrochemical Deposition Method”. 2018 GeoShanghai International Conference, Shanghai, China, May 2018.

## Dissertations

D02. **Wang, X.** (2024). “Context-Aware Worker Intent Interpretation for Human-Robot Collaboration in Construction”, Ph.D. Dissertation, University of Wisconsin-Madison, USA.

D01. **Wang, X.** (2019). “Study on Serviceability Degradation Model of Shield Tunnel Through Data Mining Methods”. M.S. Dissertation, Tongji University, China.

## News

N02. College of Engineering Blog (2024). “Xin Wang redefines human-robot collaboration in construction”. <https://engineering.wisc.edu/blog/xin-wang-redefines-human-robot-collaboration-in-construction/>

N01. CEE News & Events (2021). “Bringing automated gesture input to construction sites”. <https://engineering.wisc.edu/news/bringing-automated-gesture-input-to-construction-sites/>

## RESEARCH PROPOSALS

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2024	Title: Next-Gen Forklift Navigation System: Integrating Computer Vision and Augmented Reality for Enhanced Warehouse Productivity and Safety PI: Zhenhua Zhu; Co-PI: Dharmaraj Veeramani (Submitted to Toyota Industries Company) Roles: Writing the conceptual paper; Preparing the poster; Writing literature review related to the navigation systems for forklifts; Identifying research gaps and writing methodology; Participating in discussions for technical routes; Preparing figures
2023	Title: Hand Signal Recognition for Next-Generation Automated Guided Vehicles PI: Zhenhua Zhu; Co-PI: Dharmaraj Veeramani, Yin Li (Submitted to Toyota Industries Company but declined) Roles: Writing research opportunity and objectives; Writing literature review related to exiting interfaces for remotely controlling material handling vehicles; Identifying and writing research innovations; Participating in discussions for technical routes; Preparing figures
2022	Title: Collaboration in Labor-Intensive Tasks: Hardware-in-the-Loop Hybrid Reality with Mutual Intent Awareness PI: Zhenhua Zhu (Submitted to National Science Foundation but declined) Roles: Writing literature review and research gaps related to worker intent interpretations; Participating in discussions for technical routes; Preparing figures

## TEACHING AND MENTORING EXPERIENCES

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01/2024 – 05/2024 Independent Instructor

CEE 159 Civil Engineering Graphics, *University of Wisconsin-Madison*

- Prepared for course materials regarding drawing techniques and introduction to AutoCAD.
- Gave 13-week lectures
  - Topics: Graphical communication including lettering, drawing equipment and techniques,

geometric constructions, orthographic projections, technical sketching, isometric views, descriptive geometry, and computer-aided design drawing, with applications specific to civil engineering.

- Held office hours and lab sessions to answer the questions from students.
- Designed and refined homework and exams.
- Reviewed the grading work by TA and grader.

01/2023 – 05/2023 Co-Instructor

CEE 669 Spatial/Visual Sensing Construction, *University of Wisconsin-Madison*

- Gave lectures related to hand gesture recognition research.
- Evaluated student project progress objectively.
- Offered guidance during visit to Virtual Reality CAVE.

01/2022 – 05/2022 Teaching Assistant

CS 220/319 Data Programming I, *University of Wisconsin-Madison*

- Drafted quiz and course assignments.
- Answered questions in Piazza.
- Proctored exams.
- Held 7-hour office hours weekly to answer students' questions about lectures and assignments.
- Offered 1.25-hour lab sessions weekly to provide supplemental practice related to lectures.

05/2023 – 06/2023 Trainee

Delta Program in Research, Teaching, and Learning, *University of Wisconsin-Madison*

- Completed 10-hour research mentor training.
  - Topics addressed: Aligning Expectations, Culturally Inclusive Mentorship, Effective Communication, Assessing Understanding, Foster Independence, Building Self-Efficacy, Ethical Behavior, Designing a Mentoring Philosophy
- Explored new and emerging technologies (e.g., ChatGPT) within the context of accelerating change in teaching and learning.

06/2022 – 08/2022 Mentor

Digital and Robotic Construction Lab, *University of Wisconsin-Madison*

- Collaborated with Ph.D. students on multiple research projects and revised their manuscripts.
- Advised master students to build a sandbox to simulate construction sites.
- Advised undergraduates to process the data of the workers' feedbacks to exoskeletons.
- Evaluated student progress objectively and frequently.
- List of the students I worked with:
  - Ph.D.: Wei Han, Liqun Xu
  - Masters: Yinong Hu, Han Wu, Yaxin Wang
  - Undergraduates: Gene Tanchanpongs, Yanjie Ma

## INDUSTRY EXPERIENCES

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09/2019 – 12/2019 Software Engineer

Engineering Research Center of Civil-informatics, *Tongji University*

- Participated in building big data platforms for Tunneling Boring Machines (TBM).
- Designed and implemented data preprocessing and machine learning plug-ins based on infrastructure Smart Service System (iS3).

06/2015 – 07/2015    Project Management Intern  
*Shanghai Construction Group*

- Analyzed the foundation pit excavation process of high-rise buildings.
- Conducted the daily inspections on construction sites.

## **PROFESSIONAL AND UNIVERSITY SERVICES**

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### **Professional Affiliations**

Student Member – American Society of Civil Engineers (ASCE)

Student Member – Visualization, Information Modeling, and Simulation (VIMS)

Student Member – Data Sensing and Analysis (DS&A)

Student Member – Canadian Society for Civil Engineering (CSCE)

### **Reviewer Services**

2024 – present	Elsevier Journal of Computer Vision and Image Understanding
2024 – present	International Journal of Human–Computer Interaction
2024 – present	ASCE Journal of Computing in Civil Engineering
2024 – present	IEEE Access
2023 – present	Elsevier Journal of Automation in Construction
2023 – present	Elsevier Journal of Advanced Engineering Informatics
2023 – present	Elsevier Journal of Tunnelling and Underground Space Technology
2023 – present	Elsevier Journal of Underground Space
2023 – present	Journal of PLOS ONE
2020 – present	ASCE Journal of Construction Engineering and Management
2024	41 <sup>th</sup> International Symposium on Automation and Robotics in Construction, France
2023	2024 CI & CRC Joint Conference, Des Moines, Iowa
2023	40 <sup>th</sup> International Symposium on Automation and Robotics in Construction, India
2022	39 <sup>th</sup> International Symposium on Automation and Robotics in Construction, Colombia
2021	2022 CI & CRC Joint Conference, Arlington, Virginia
2021	38 <sup>th</sup> International Symposium on Automation and Robotics in Construction, UAE



## Leadership and Broader Impact Activities

2024, 2023, 2022	Presenter Engineering Exposition, <i>University of Wisconsin-Madison</i>
04/2023	Presenter Wisconsin Robotics Symposium, <i>University of Wisconsin-Madison</i>
09/2015	Volunteer Pujiang Innovation Forum, <i>Chinese Ministry of Science and Technology</i>
11/2014	Volunteer Centennial Celebration of Civil Engineering, <i>Tongji University</i>
2013 - 2014	Member Student Union, <i>Tongji University</i>

## COMPUTER SKILLS

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**Programming Languages:** C/C++, MATLAB, R, Python, SQL, GAMS

**Deep Learning Libraries:** Pytorch, TensorFlow, Keras, Numpy, OpenCV

**Construction-Related Software:** AutoCAD, Revit, ABAQUS, Primavera, WinEst

## LANGUAGES

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**Chinese** - listening, speaking, reading, and writing (native language)

**English** - listening, speaking, reading, and writing